PERIODICAL ROOM
GENERAL LIBRARY
UNIV. OF MICH.

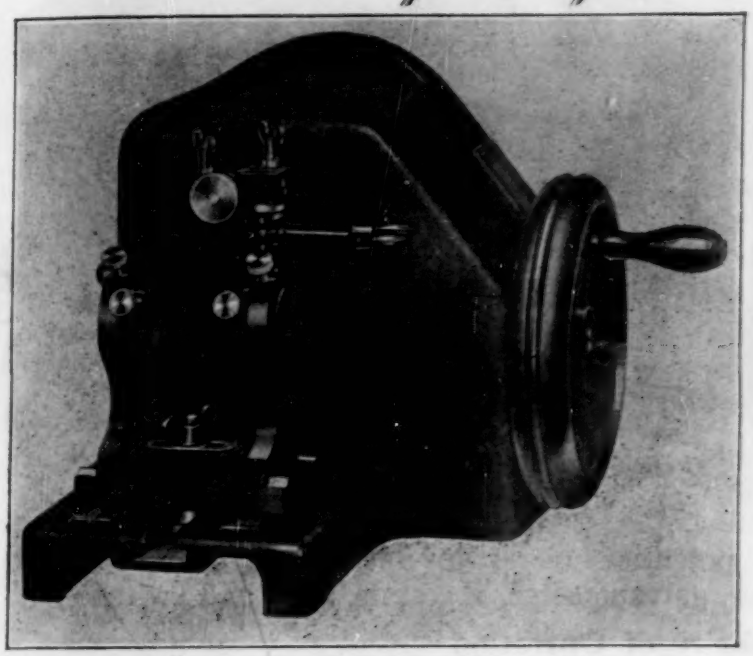
SCIENCE

JUN 24 1929

NEW SERIES
VOL. LXIX, No. 1799

FRIDAY, JUNE 21, 1929

ANNUAL SUBSCRIPTION, $6.00
SINGLE COPIES, 15 CTS.



Minot Automatic Microtome

THIS instrument was designed by the late Dr. Charles S. Minot, and has been improved by us from time to time until it is now justly one of the most popular microtomes on the market. The latest improvement, of which this is the first listing, consists of a cover completely enclosing the feeding mechanism and a grooved balance wheel which provides for using a motor to operate the instrument. This microtome is an ideal instrument for rapid serial sectioning, cutting sections with accuracy down to one micron in thickness. While regularly furnished for paraffin sectioning only, this model can be equipped for cutting small celloidin specimens.

Two New Improvements

1. The entire feeding mechanism is enclosed in a metal case to protect the working mechanism and keep out dust. The cam disc which controls the amount of feed is operated from outside the case. The figures indicating the amount of feed can be seen through a glass window provided for that purpose.
2. The drive wheel is grooved so that the microtome can be operated by a motor when desired.

Send for complete information

Bausch & Lomb Optical Co.

632 St. Paul St., Rochester, N. Y.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

A Quinhydrone Hydrogen Ion Apparatus

Designed after Specifications by W. J. Youden, Ph. D., of the Boyce-Thompson Institute for Plant Research

Low Cost and High Precision

Simple and Rapid Manipulation.

(Patent Pending.)

THE Youden pH Apparatus is a potentiometer set-up with quinhydrone electrodes. It is complete with millivoltmeter, galvanometer, rheostats, keys and switches.

Simplicity of Operation

No technical knowledge or skill is necessary. With unknown solution in reference tube, adjust the rheostat to cause the galvanometer to read zero. The voltmeter reading is noted and the pH for this voltmeter reading is found in a table supplied.

Special Features of Superiority

Rapid Manipulation. 30 to 40 determinations per hour, more than twice as rapid as any other electrometric method.

Low Cost. The use of quinhydrone electrodes permits using a millivoltmeter of 300 mv. range.

Sensitivity. Equivalent to .03 pH—as high as is necessary in practical work, and considerably greater sensitivity than the most precise colorimetric methods.

Portability. All sets are light weight. Field sets in carrying case.

Simplicity. Component parts are simple, durable, and convenient.

No. 5270 Youden Hydrogen Ion Concentration Apparatus. Complete with millivoltmeter, galvanometer, rheostats, special quinhydrone electrodes, and chemicals and supplies necessary for operation **$85.00**

A portable set in carrying case with handle is also supplied. Write for prices.

PACIFIC COAST DISTRIBUTORS

Braun-Knecht-Heimann Company
576–584 Mission Street
San Francisco, California

Braun Corporation
363–371 New High Street
Los Angeles, California

A Sign of Quality QUALITY WELCH SERVICE *A Mark of Service*

W. M. Welch Scientific Company

1516 Orleans Street — Manufacturers, Importers and Exporters of Scientific Apparatus and School Supplies — Chicago, Ill., U. S. A.

SCIENCE

VOL. LXIX JUNE 21, 1929 No. 1799

CONTENTS

The Application of Transmittancy Measurements to Biochemistry: DR. FRANK M. SCHERTZ 631

Charles Depéret: DR. HENRY FAIRFIELD OSBORN 636

Franz Keibel: G. L. S. 637

Carey V. Hodgson: DR. WILLIAM BOWIE 637

Scientific Events:
The Production of "Talking" Motion Pictures by the U. S. Department of Agriculture; The Giannini Foundation of the University of California; The Settlement of the Undeveloped Areas of Canada; The Cornell Center for Research in Biophysics; The Thirteenth Summer Meeting of the American Mathematical Association 638

Scientific Notes and News 641

University and Educational Notes 644

Discussion:
Gift to Down House of the Original Letters of Charles Darwin to Fritz Müller: DR. HENRY FAIRFIELD OSBORN. *A Case of Accidental Parasitism.* PROFESSOR GEORGE W. HUNTER, III. *Cephenomyia sp. Killing Deer;* C. R. WALKER. *Solar Eclipses:* MILLICENT TODD BINGHAM 645

Scientific Books:
Ladd-Franklin's Colour and Colour Theories: PROFESSOR HOWARD C. WARREN. *Brunt's Meteorology:* DR. W. J. HUMPHREYS 647

Scientific Apparatus and Laboratory Methods:
Apparatus for the Detection of Substratum Communication among Termites: PROFESSOR ALFRED E. EMERSON and ROBERT C. SIMPSON. *An Accurate Drop Recorder:* PROFESSOR O. S. GIBBS 648

Special Articles:
A Study of Iodine in South Carolina: J. H. MITCHELL. *A New Disease of Douglas Fir:* NATHANIEL O. HOWARD 650

Science News x

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal.

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00. Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

THE APPLICATION OF TRANSMITTANCY MEASUREMENTS TO BIOCHEMISTRY[1]

INTRODUCTION

MANY years ago at Troas, a visioned Macedonian came to Paul seeking assistance. From that hour the Macedonian left no doubt in Paul's mind as to the way he might best serve. So he took a straight course for Samothracia, and then on to Philippi.

To-day, we who are engaged in biochemical work have long sought help in the solution of our problems. As the Macedonian came to Paul, so we come to you for assistance in our labor. Meanwhile we have been marking time, pyramiding our evidence and quibbling about many of the non-essentials, while the real problem all the time unattacked has been lying before us. Our mutual problems are as full of spiritual significance and humanitarian interest as were those of the Macedonians, and should be considered no less seriously. The correct interpretation of every experiment has tremendous spiritual significance and every experimenter should most courageously guard the interpretation of his experimentation. Every interpretation should be pictured as a grain of truth, which, when put with other grains of truth to form a unified whole, will make the world in which we live one of reality and not one of superficiality. The biochemist again and again has looked to one branch of science and then to another for suitable methods of investigating his problems. He is beginning to realize that something not found in a test-tube or in any mechanistic physical-chemical philosophy of life must come to aid him in his efforts. New procedures, new interpretations and independent thinking seem imperative. The relation of light to matter appears on the horizon offering assistance in many of the modern problems which confront those investigating the chemistry of life. This paper is an attempt to show how properties of light will assist us in the solution of problems which as yet remain unsolved after many years of struggle. Light and chlorophyll, which are both so commonly known and so little understood, are worthy of our most critical examination.

EARLY INVESTIGATIONS

Approximately one hundred years ago David Brewster discovered fluorescence in fluorspar. His

[1] Paper given before the Optical Society of America at the Bureau of Standards, November 3, 1928.

discovery was reported to the Royal Society of Edinburgh in 1833. In 1846 he reported the discovery of fluorescence in an alcoholic solution of leaf-green. One year before this, John Herschel discovered that quinine sulphate when placed in sunlight "gave off a blue color."

OBSERVATIONS OF STOKES[2]

G. G. Stokes repeated the experiments of these two workers, and the results obtained caused him to take a most lively interest in the phenomenon. He made many interesting observations, which were reported to the Royal Society in 1852. Using the light of a candle and a single isolated prism, he observed five absorption bands in an alcoholic solution of nettle leaf-green. He made the suggestion that the intense band No. 1 be used as a chemical test for the presence of chlorophyll. Later he observed that absorption commenced at about the fixed line B, and continued onward throughout the visible spectrum and beyond. The absorption was noticed to be subject to fluctuations, which were intimately connected with the absorption bands exhibited by this medium. Again he noticed that when a tube of quinine sulphate solution was plunged into the invisible rays of the spectrum the phenomenon had something of an unearthly appearance; it was literally darkness visible. It was observed that absorption of light, or change of refrangibility as he called it, was extremely common, especially in organic substances.

In 1864 he writes further: "I find the chlorophyll of land plants to be a mixture of four substances, two green and two yellow, all possessing highly distinctive optical properties. The green substances yield solutions exhibiting a strong red fluorescence; the yellow substances do not."

At the age of forty-five he addressed the fellows of the Chemical Society with the following words: "The optical properties of bodies, properly speaking, include every phenomenon in which ponderable matter is related to light by virtue of its molecular constitution, and not merely of its external form." He states further that spectral analysis is most valuable for the detection of elementary bodies and can not of course be applied to organic analysis. Absorption, fluorescence and reflection, however, are optical properties of bodies which can be used in organic analysis, for these properties vary markedly from one wavelength to another. Again he says:

> But in most cases, especially with substances of intense colorific power, the mode of absorption is eminently characteristic. Two or more dark bands are seen in the spectrum, indicating maxima of absorption; and the position of these bands, their relative intensity, and their other features, form altogether a series of characters the distinctive nature of which is such as those who have neglected the use of the prism have little conception of. They render it perfectly easy in many cases to follow a particular substance among a host of impurities. For each colored substance produces its own absorption, independently of the others, so that, unless the part of the spectrum in which the distinctive bands, or most of them, occur is wholly absorbed by the impurities, the presence of the substance can still be recognized. Not only is an examination of the absorption spectrum of a substance useful for enabling us to follow the substance through mixed solutions, but it sometimes reveals relationships in cases in which they might not be suspected, if the origin of the substances were unknown.
>
> The phenomenon of fluorescence gives in some cases material assistance, but in general it is only by combining spectral analysis with processes of chemical separation, especially fractional separation, that a satisfactory conclusion can be arrived at. When a mixture is thus tested in various ways, a conviction is gradually arrived at that those bands of absorption which are always found accompanying one another belong to one and the same substance.
>
> For convenience and rapidity of manipulation, especially in the examination of very minute quantities, there is no method of separation equal to that of partition between solvents which separate after agitation. . . .
>
> Bisulphide of carbon in conjunction with alcohol enabled the lecturer to disentangle the colored substances which are mixed together in the green coloring matter of leaves.

From this last paragraph it is revealed that Stokes was the first to make use of the fractionation method to separate the green chloroplast pigments from the yellow ones, and to roughly separate chlorophyll *a* from chlorophyll *b*.

INVESTIGATIONS OF WILLSTÄTTER[3]

The writings of Willstätter reveal that valuable observations of students of natural science, to whom the application of chemical methods was not familiar, exerted no influence upon the development of our knowledge of chlorophyll. Chemical literature ignored statements and suggestions of the great physicist and those of botanists, or treated them disrespectfully. As a consequence, important hints on the existence of two components of chlorophyll, which occur in the optical treatise by Stokes, fell on unfruitful soil and the fascinating microscopical observations of J. Borodin went unheeded by analysts.

[2] G. G. Stokes: (1) "On the Supposed Identity of Biliverdin with Chlorophyll with Remarks on the Constitution of Chlorophyll." Proc. Roy. Soc. London, Feb. 25, 1864. (2) "Mathematical and Physical Papers," Vol. 3, 1901. 413 pages. (3) "On the Application of the Optical Properties of Bodies to the Detection and Discrimination of Organic Substances," *Jour. Chem. Soc.* 17: 304–311, 1864.

[3] Richard Willstätter and Arthur Stoll, "Investigations on Chlorophyll," 1928.

Willstätter and his coworkers, by making use of suggestions of the physicist Stokes and those of the botanist Borodin, successfully accomplished what many chemists before them had failed to do.

It was from the writings of Borodin that Willstätter learned how to prepare ethyl chlorophyllide, which was used as the basis for determining the purity of the chlorophyll preparations. From the writings of Stokes he learned of the possibility of separating chlorophyll *a* from *b* by means of non-miscible solvents. In 1913, using a new fractionation method, petroleum ether and methyl alcohol, with ethyl chlorophyllide as a basis for his colorimetric determinations, he obtained the two chlorophyll components. Preliminary spectroscopic investigation revealed eight bands belonging to chlorophyll *a* and ten belonging to chlorophyll *b* in the visible spectrum. No record is made of any observations beyond the visible. Colorimetric and spectroscopic methods were available to Willstätter for determining the amount of chlorophyll present in a solution. The former was used by him because component *a* optically masks *b*, the pigments were highly unstable and the absorption properties may be considerably altered by the influence of even a small amount of plant acid in the extract. In the preparation of chlorophyll, colorimetric tests alone were not sufficient to establish its purity. Chemical tests, such as the determination of carbon, of hydrogen or nitrogen, of magnesium, or of the melting-point, were of little value. Other chemical tests were devised to tell if transformations had taken place in the molecule. It was Willstätter's belief that when better methods exist for the isolation of the pigments, quantitative transmittancy methods could be used for improving the determinations.

The investigator of chlorophyll must realize also that Willstätter has found that many important chemical changes of chlorophyll and its derivatives exert little or no influence upon the absorption spectrum, while, on the other hand, certain insignificant changes of constitution produce rather large changes in the spectrum.

Willstätter tells us that future investigations on the constitution of chlorophyll will still find important problems. The relations between *a* and *b* chlorophyll and the transformations which led from chlorophyll to the chlorophyllins and from the chlorophyllins to the dibasic phyllins are yet to be explained, and important details of the structure of etioporphyrin remain to be investigated. The strange names used here are only names for derivatives of chlorophyll.

On still another page, he concludes from chemical analysis that the difference between the *a* and the *b* series probably consists in a molecule of oxygen, two hydrogen atoms of chlorophyll *a* being replaced by one oxygen atom in chlorophyll *b*. This assumption he admits has by no means been proved. The assumption is only a provisional one to render the relations between the two components understandable, not forgetting that further investigations are needed to fix and strengthen this explanation.

THE SITUATION TO-DAY

Many of us to-day are under the impression that Willstätter has written the last word on chlorophyll, but from his own writings it is learned that our knowledge regarding the most important organic nitrogen compound, which is produced by nature annually in the United States alone at the rate of many million tons, is very elemental. It is well known that light is related in some way to chlorophyll, and we are beginning to become conscious of the fact that both in some important way are related to your life and mine.

Our knowledge regarding this substance has reached the stage where chemistry alone will not solve the problem—chlorophyll, what is it? As a substance or quality is weighed or measured our knowledge concerning the thing investigated is mastered in proportion to the accuracy of our measurements. So if more about a quality or a substance would be known, it must be measured very precisely. So long as a substance exists as a mixture or so long as we mentally mix two or more qualities, little can be learned about either of them. Our first problem then is to highly refine the thing investigated or to get it in as pure a state as possible. Before a thing can be obtained pure a standard of its purity must exist in our minds. Purification is one of the most difficult problems confronting any investigator. Purity is of first consideration when absorption measurements are made of any substance. To make absorption measurements and know that they belong to a substance, that substance must first be isolated from all other substances which would in any way affect its absorptive properties.

FUTURE WORK ON CHLOROPHYLL

Specifically, to fractionate chlorophyll *a* from *b*, more than a colorimeter and more than chemical tests are necessary. Transmittancy methods alone appear sufficiently critical for the undertaking. Future work on chlorophyll will progress only as fast as the work of the chemist is correlated with that of the physicist. Purer chlorophyll can be prepared and chlorophyll *a* can be separated from chlorophyll *b* only as step-by-step investigation is made of the purity of the substances. This may best be done in cooperation

with the physicist by testing the per cent. of light that is absorbed at different wave-lengths from the extreme infra-red to the extreme ultra-violet. We will then know positively that we have pure chlorophyll *a* and *b*, as they exist in the plant when every band is accurately known to have the same magnitude, shape and position that it has in living green leaves or know why there has been any alteration in the absorption curve. The data obtained will be invaluable in accurately estimating the two pigments in problems concerning plant physiology.

Future investigations on preparations that to-day we know are impure will be of little value compared to investigations made on preparations of the highest purity. Commercial centrifugals already developed will perhaps be of great value in speeding up every stage of the preparation of chlorophyll. To get a pure product, speed is of primary importance, for chlorophyll evidently undergoes decomposition at every stage of its preparation.

To-day, in addition to a study of the two chlorophyll components, there is need of a study of the absorption properties of all the important chlorophyll derivatives. Every possible chemical compound produced by breaking down the most important nitrogen compound in the world is worthy of examination by the most critical methods available. Who is so wise as to know in what form some natural product formed from chlorophyll may appear in every living cell? Once the characteristics of these compounds in a pure state are known, their presence may be easily established.

Already transmittancy measurements have been used to control the preparation of two important biochemical compounds. Transmittancy data of carotin and of xanthophyll, the purity of which was tested spectrophotometrically, will be presented to-day by McNicholas, as evidence of what has been done already in the use of such data as a control in the preparation of pure chemical substances. What has been done with carotin and xanthophyll can be done with chlorophyll *a* and chlorophyll *b* and any other organic substance.

One man highly trained and with a little assistance, by making use of the spectrophotometric data already obtained on optical instruments at the Bureau of Standards, could find out more in one year about the carotinoid pigments present in plants and animals than a host of workers have discovered in a hundred years. With Hardy's recording color analyzer I now find that this work could be done in a single day. Instead of using 6,000 eggs or 10,000 ovaries, the presence of xanthophyll or carotin could be conclusively proved by using a single egg or a single ovary. To-day, the final proof of the identity of two chemical compounds is furnished by transmittancy data of substances which need not necessarily be highly purified.

Application of Transmittancy Measurements to Other Fields

The physicist of to-day has rendered a great service to all biochemists, for by the use of his instruments traces of organic compounds may be quite easily detected. Every chemical compound absorbs light in some portion of the spectrum, and this fact should be taken advantage of by all who have biochemical problems worthy of solution. Chemical tests are often not sufficiently critical to aid us in the solution of many of our problems in which transmittancy measurements are very helpful.

There is every reason to believe that spectrophotometric methods can be used to solve problems in protein synthesis, nutrition of plants and of animals, problems in photochemical processes, and many others which are most fundamental. Every phase of nitrogen chemistry is worthy of our deepest study, for our very lives seem to be tied up in an intimate way with nitrogen. In an American laboratory plans are already well under way for an intensive spectrophotometric study of certain proteins.

In the field of systematic botany for hundreds of years attempts have been made to find a natural system of classification for plants. Evidence is accumulating that each group of plants has a chemistry peculiarly its own. The chemist too for a long time has sought to know order in nature, in the inorganic and organic worlds. The present system of classification of biochemical compounds is most probably as artificial as have been those proposed in an attempt to find a natural system in plant classification. Botanists by cooperating with chemists should discover much that will aid them to understand nature's chemistry. Fractional separation methods using organic solvents and the new physical instruments offer hope of a solution of this important problem.

A study of the absorption bands of ergosterol has already revealed much regarding its chemical nature. The instruments developed are valuable too for use in routine chemical analysis of inorganic substances as well as substances in the organic world. Ferrari recently has used transmittancy measurements in studying very accurately the effect of various bleaching agents on the carotinoids in flour. Shapiro[4] has used transmittancy measurements to solve problems in organic chemistry involving hydroxyl substitution and the presence of the meta-quinoid structure in organic molecules. Otto Warburg[5] has made use of these measurements to show that the respiration

[4] *Jour. Am. Chem. Soc.*, 50: 1772.
[5] SCIENCE, No. 1767, 68: 437–443. 1928.

ferment is in many respects quite similar to all known hemin compounds. The absorption maximum of respiration ferment is slightly displaced toward the red in respect to the other hemin compounds. Spectroscopically, chlorophyll in solution has about the same relation to chlorophyll in the cell as the hemin compounds have to respiration ferment. Warburg has also made use of a new principle whereby the absorption spectrum of a substance can be indirectly determined from the photochemical activity of the given substance. Frank Wokes[6] has made a study of the transmittancies of the colorations which have been attributed to vitamin A. Vitamin A has been shown by Morton and Heilbron[7] to possess an absorption band with a maximum at 328 μμ while one of the decomposition products of this vitamin has an absorption band near 275–285 μμ. A study of the vegetable oils by Priest[8] has revealed the presence of chlorophyll and its decomposition products in all the oils examined. Olive oils were high in chlorophyll-like substances while cottonseed oil contained varying amounts. The velocity with which oxygen combines with reduced hemoglobin has been measured by Hartridge and Roughton[9] with a spectrophotometer. Rates of other chemical reactions can be measured. Measurements of the color of iodine solutions in typical solvents and of the effect of ultraviolet light on iodine solutions have been made by Getman.[10] The value of these instruments once fully comprehended will make them indispensable to every chemical laboratory.

If we are ever to learn much more about the structure of molecules the information is likely to come from a study of the absorption bands of compounds. The spectra of compounds can only be understood by finding order in their arrangement and relations of the absorption bands to the structure of the molecules.

In the biochemical field to-day there is need for a Rowland to map accurately the great variety of absorption spectra of pure organic compounds. The physicist already in one generation has brought amazing order out of an utter chaos of wave-lengths and he too can assist us in bringing order out of a mass of organic compounds which to-day is nothing but confusion.

[6] "Spectroscopic Study of the Colorations Attributed to Vitamin A," *Biochem. Jour.*, 22: 987–996. 1928.

[7] R. A. Morton and I. M. Heilbron, "The Absorption Spectrum of Vitamin A," *Biochem. Jour.*, 22. 1928.

[8] Irwin G. Priest, "The Color of Soy-Bean Oil as Compared with That of Cottonseed Oil." The Cotton Oil Press, III, 37–40, 1920.

[9] H. Hartridge and J. W. Roughton, *Proc. Roy. Soc.*, 107: 654–683, 1925.

[10] Frederick H. Getman, *Jour. Am. Chem. Soc.*, 50: 2883–90, 1928.

If transmittancy measurements were made of every important biochemical compound highly purified, at once there would exist a standard basis of comparison for all biochemical work. The question—how much?—could be easily answered for every problem. A few minutes' examination of any given solution could settle immediately the presence or absence of a certain organic compound. Such measurements will assist us in discovering new organic substances as well as teach us to give only one name to substances now supposedly different.

A spectrophotometer is already being used by Shull to demonstrate conclusively that there is reason to question classical studies which have been made in the field of plant physiology. They are being used by others to show the physical condition of the human body and the progress of disease by simply analyzing the body fluids. Specific changes going on in ripening processes can be followed as well as many other chemical transformations involved in plant growth.

Biochemists need no longer be content to report results in millimeters on a colorimeter nor should they be longer content to report the results of tissue analysis in terms of ether and alcohol extract when it is possible to follow the course of any compound in a plant or animal. It is far better to know something definite about the complete life relations of a single organic compound than to talk glibly about many, as we now do.

The time has come when we must no longer use terms to cloak our ignorance or labeled pigeonholes into which we can stuff anything about which we know little or nothing. Error and ignorance will and must be discovered. Annually we are spending hundreds of thousands of dollars and taking much time to make practical applications in science without making certain of the soundness of the fundamentals upon which these practical applications are based. We are beginning to learn that transmittancy measurements are as valuable in the field of biochemistry as emission spectra are in the field of inorganic chemistry. As the spectroscope opened a vast unexplored territory for the analytical chemist as well as the astronomer, so the spectrophotometer opens a vast unexplored territory for the biochemist. It gives us a new instrument which should greatly assist in solving the relation of light to matter. We as biochemists would like to know more about the radiation hypothesis and more about Einstein's equivalence law, and about the chain reactions that are undoubtedly going on everywhere about us. Attempts should be made to correlate data for inorganic substances with data for organic substances, thus bridging or wiping out the gap between living processes and those assumed to be not living.

To do this, the Englishman must talk Chinese to the Chinese and the man from China must talk English to us. We are not effectively doing this now, but your society is doing more than any other agency to standardize procedures and make intelligible to those in other fields the work of the optical physicist and your president is doing his share of the work. We can only make use of your instruments as you make it possible for us to understand and use them. But we too are to blame, for our words and phrases so often must be only meaningless words to you, for so often we discover that they mean very little to us also.

CONCLUSION

In a very brief way I have tried to show how absorption spectra have been intimately related to the development of our knowledge of chlorophyll. One hundred years ago Stokes discovered several laws that are very applicable to-day. For apparatus he used a boarded-up window, a slit in a plank, a lens and a prism. Instead of thinking how much we have accomplished with highly refined instruments we biochemists should rather humble ourselves by thinking how little use we have made of the instruments which you have so nobly perfected.

For fifteen years the work of Willstätter has lain almost unnoticed. Perhaps much more time must elapse before we become conscious of how to apply the principles and procedures which he has developed for fractionally separating an organic substance from many others. He has successfully isolated four chemical substances from masses of organic substances most difficult to manipulate. What has been done with chlorophyll *a* and *b*, carotin and xanthophyll can be done with other organic substances. By spectrophotometric methods any substance can be traced through any number of fractional separations. Transmittancy measurements combined with centrifugal methods and fractional separations in solvents should make it possible to separate organic substances of which our knowledge as yet is very incomplete. Delay in using fundamental principles discovered by others is a question of psychology and not one of biochemistry or physics. Our delay is measured by the amount of time that it takes us to become wholly conscious of that which most unconsciously lies immediately before us—much that we have learned must be temporarily forgotten before we can become conscious of the real situation. It is further measured by our stubborn unwillingness to give up ideas which we have held from our youth. Once we get the viewpoint our sails will be set in a straight course to study the things that are fundamental and so full of spiritual significance for us all. Our concern is with life and how to live it more normally and completely by living in complete harmony with nature's laws and not forever opposing them. That is my motive for a critical study of biochemical compounds, using light, a fundamental something which can be accurately measured, as a final test.

FRANK M. SCHERTZ
BUREAU OF CHEMISTRY AND SOILS,
U. S. DEPARTMENT OF AGRICULTURE

CHARLES DEPÉRET

THE sad news comes from the University of Lyons of the sudden death of Professor Charles Depéret, dean of the science faculty of the University of Lyons and one of the most distinguished leaders in the long line of paleontologists of France who have succeeded Cuvier, the founder of this great branch of biology. According to a note received from M. Frédéric Roman, professor of geology in the University of Lyons, the death of Professor Depéret occurred, following a geological excursion in the south of France.

Charles Depéret was eminently a collector and field observer both in vertebrate and invertebrate paleontology. He naturally succeeded Albert Gaudry in the series of monographs on the fossil mammalia, especially of Southern France, so that we owe to him the scheme of geologic and paleontologic correlations between the Upper Tertiaries of France, England and Italy, which have been elaborated through the work of the present writer into very close comparisons of the Tertiary faunal horizons. Both in descriptive and in philosophic paleontology, Charles Depéret was a master. His talent in invertebrate paleontology and geology was not only shown in his great correlation scheme of the Tertiaries but was extended in recent years into the correlation of the Pleistocene through the rising and falling sea-levels and shore-lines surrounding the Mediterranean and extending up along the eastern borders of France and Great Britain. The establishment of four great *Étages* dividing the Pleistocene by marine stages similar to those by which the Pliocene and preceding Tertiaries are divided is his last and perhaps one of his greatest contributions to geology and paleontology.

He was a man of most genial and delightful personality, generous in the exchange of ideas and materials and inspiring to all the younger men who came in contact with him. Thus he leaves a school of younger geologists and paleontologists, many of whom have collaborated with him and participated in his field excursions and observations, and will sustain the high traditions of French paleontology and geology. To all these colleagues in the University of Lyons and to members of his family we extend our most

sincere sympathy and this expression of our profound admiration and esteem.

Among his principal works were: "Recherches sur la succession des Faunes de Vertébrés Miocènes de la vallée du Rhône" (1887); "Les Animaux Pliocènes du Rousillon" (1890); "La Faune de Mammifères Miocènes de la Grive-St. Alban" (1892); "Les Vertébrés Oligocènes de Pyrimont-Challonges (Savoie)" (1902); "Les Transformations du Monde animal" (1907); "Monographie de la Faune de Mammifères fossiles du Ludien inférieur d'Euzet-les-Bains (Gard)" (1917).

HENRY FAIRFIELD OSBORN,
Membre de l'Institut de France

FRANZ KEIBEL

WORD has been received of the death of the German embryologist, Franz Keibel. Following a prolonged illness he died in his 68th year on April 27, 1929, in Berlin. Professor Keibel was well known to the anatomists in America, many of whom worked under him in his Freiburg days. A still wider acquaintance has resulted from the series of publications entitled *Normentafeln zur Entwicklungsgeschichte,* an encyclopedic survey of the embryonic anatomy of various groups of vertebrates, and from the "Manual of Human Embryology," edited in collaboration with Professor Mall. The latter constitutes the most comprehensive treatment of human embryology that has ever been produced. In both of these important works there was participation on the part of American investigators and this led to exceptionally close relations between Professor Keibel and the workers in this country. In 1906 he received the honorary degree of LL.D. from Harvard University and for the years 1914 to 1917 he had an appointment as research associate of the Carnegie Institution of Washington, collaborating with the newly established department of embryology.

The greater part of Professor Keibel's scientific activities were prosecuted in Freiburg i. Br. During this fruitful period he became widely known through his numerous morphological studies in vertebrate embryology and through his larger treatises on such problems as gastrulation, cephalization, the germ layers and the origin of the mesoderm. Among these are found papers that will endure for all times. His scholarship and his talent as a teacher found their expression in the works mentioned above, the "Normentafeln" and the "Manual of Human Embryology," both of which are outstanding contributions.

In 1917 he succeeded Schwalbe as professor of anatomy at Strassburg, only to lose the position a year later upon the occupation by the French. The transfer of Sobotta to Bonn made an opening for him at Königsberg i. P., where he became ordinarius and director of the anatomical laboratory in 1919. Three years later (1922) upon the retirement of Oskar Hertwig he was appointed professor of anatomy and director of the anatomico-biological institute of the University of Berlin, a chair of distinction, and this he held until the time of his death.

G. L. S.

CAREY V. HODGSON

CAREY V. HODGSON, hydrographic and geodetic engineer and assistant chief of the division of geodesy, U. S. Coast and Geodetic Survey, and his ten-year old son, were drowned while canoeing in Chesapeake Bay, near Annapolis, on Sunday, May 19, 1929. His body was recovered on May 22 and buried, with full military honors, in Arlington National Cemetery on Saturday, May 25. At the time this was written, the body of his son had not been recovered.

Major Hodgson was born at Wilmington, Ohio, July 11, 1880. He was a graduate of Wilmington and Haverford Colleges, receiving a B.S. degree from both of these institutions. He entered the field service of the U. S. Coast and Geodetic Survey March 31, 1904, and remained with that bureau until his death except for a short period when he was engaged in private engineering work, and during the World War.

In 1917, he was transferred to the Corps of Engineers of the Army and commissioned a captain. He served in France with the 29th Engineers and, while there, was promoted to the rank of major. On March 9, 1929, he returned to the U. S. Coast and Geodetic Survey and resumed his duties with that bureau.

While in the Coast and Geodetic Survey he served on many hydrographic and topographic parties and also on vessels of that bureau engaged in surveying the waters of Alaska and the Philippine Islands. While in the Philippines, he commanded the survey ship *Research.* He had charge of many geodetic parties, engaged principally in triangulation, base measurement and the astronomic determinations of latitude and longitude. He was appointed assistant chief of the division of geodesy in 1920 and served in that capacity until his death.

Not only did he make a notable record in the latter position, showing marked executive and technical ability, but he also took an active part in other engineering lines. He was secretary of the executive committee of the division of surveying and mapping of the American Society of Civil Engineers, member and director of the Washington Society of Civil Engineers, member and director of the Society of Amer-

ican Military Engineers, fellow of the American Association for the Advancement of Science, member of the American Geophysical Union, the American Geographical Society, the Washington Academy of Sciences, the Philosophical Society of Washington and the Cosmos Club of Washington.

Major Hodgson had a broad grasp of all surveying and mapping activities and of their relation and importance to engineering and industrial developments. He was the author of several reports and manuals of the Coast and Geodetic Survey dealing with geodetic subjects, as well as many papers on surveying and mapping subjects which appeared in technical journals.

Due to his writings, his activities in engineering societies and his recognized ability as an engineer, Major Hodgson was one of the most widely known members of the Coast and Geodetic Survey. In addition to his high professional qualifications, he possessed a personality and character that impressed most favorably all those with whom he came in contact. His untimely death is not only a loss to the Coast and Geodetic Survey, but to the entire engineering profession.

WILLIAM BOWIE

SCIENTIFIC EVENTS

THE PRODUCTION OF "TALKING" MOTION PICTURES BY THE DEPARTMENT OF AGRICULTURE

THE production of "talking" motion pictures will be undertaken by the Department of Agriculture this year, and if present plans are carried out one or more "all talkie" short features will be ready for presentation at the livestock shows next winter.

For the present the production of talking pictures will be limited to short specials, for such occasions as the National Dairy Show, where facilities for reproduction can be provided, but as soon as portable equipment for sound pictures is available at a cost lower than now the production of talking films for general circulation will be undertaken. The office of motion pictures has been investigating portable projectors with sound attachments.

The bureau of agricultural economics sees a special advantage in vocalizing films which deal with economic phases of farming, believing that the exhibition of sound pictures on the agricultural outlook, for example, would aid greatly in the efforts to induce farmers to study prospective demand for their products in adjusting production activities.

At one time magic-lantern slides "with lectures" were the only available method of depicting agricultural production and marketing on the screen. Then the movies came. They were "flickers" for a time, but with the establishment of a modern motion-picture studio in the department at Washington a few years ago and the borrowing of a few of the commercial movie methods a large number of excellent pictures have been produced by the department.

The demand for films of the U. S. Department of Agriculture is usually greater than the supply. Not infrequently the pictures are used in metropolitan theaters in addition to the wide use in rural movie houses, schools and assembly halls. Many foreign governments interested in American agricultural technique have shown the pictures abroad. As the commercial pictures have promoted American foreign trade in clothing, house furnishings and the like, so it is believed the American agricultural films may have contributed something to the increase in sales of American farm machinery in old world agricultural regions.

THE GIANNINI FOUNDATION OF THE UNIVERSITY OF CALIFORNIA

THE Giannini Foundation for Agricultural Economics, endowed by a million-dollar gift from A. P. Giannini, will be developed as an integral part of the college of agriculture of the University of California, according to a plan of organization outlined by Director C. B. Hutchison, of the foundation, and approved by the board of regents.

The plan provides that the director of the foundation will report to and through the dean of the college of agriculture; the funds of the foundation will be administered in the college of agriculture in as intimate association as possible with the administration of other funds received by the college from federal, state or other sources, that are applicable to the subject of agricultural economics in its broadest terms.

It is proposed to include in the staff of the foundation the members of the division of agricultural economics, such members of the agricultural extension division as are engaged in economic investigations and such other members of the staff of the college of agriculture, and other divisions of the university whose interests and fields of work give promise of contributing to the advancement of the purposes of the foundation.

An advisory committee is provided, to consist of the dean of the college of agriculture, the director of the agricultural extension service, the director of the Giannini Foundation, an outstanding financier and three successful representatives of agriculture.

It will be the function of this committee to advise with the director and his staff in respect to the activities of the foundation.

The personnel of the staff in the initial stages of development will be: C. B. Hutchison, director; Frank

Adams, professor of irrigation investigations and practice; R. L. Adams, professor of farm management; E. W. Braun, specialist in agricultural extension; B. H. Crocheron, director of agricultural extension; H. E. Erdman, professor of agricultural economics; L. W. Fluharty, specialist in agricultural extension; Walter Mulford, professor of forestry; S. W. Shear, assistant agricultural economist; E. C. Voorhies, associate professor of agricultural economics; David Weeks, associate professor of agricultural economics; H. R. Wellman, specialist in agricultural extension; C. H. West, assistant agricultural economist, and F. R. Wilcox, specialist in agricultural extension.

All papers dealing with agricultural economics emanating from members of the staff or graduate students or assistants working under their direction will be given a serial number and will appear as contributions of the Giannini Foundation, regardless of where they are published.

THE SETTLEMENT OF THE UNDEVELOPED AREAS OF CANADA

THE American Geographical Society has issued a statement in regard to its plan of conducting a scientific study of the settlement of undeveloped areas of Canada and later of other regions of the world which it has undertaken to finance. In order to deal with the many problems that affect agriculture, settlement and immigration it is expected that the investigations will extend over three or four years.

While the study is under the general supervision of a committee of the society, a Canadian committee headed by Dr. W. A. Mackintosh, professor of political and economic science, Queen's University, Kingston, Ontario, has been formed and the work has already been started. The initial research will be confined to the prairie provinces, Manitoba, Saskatchewan and Alberta.

It is planned to appraise the natural resources of the pioneer regions, to study methods of settlement with a view to avoiding the waste of life and capital that has characterized pioneer settlement in the past, and to trace the successive stages of utilization of natural resources and the effects on economic and social institutions.

On May 24 and 25 a group of scholars from Canada and the United States met in Ottawa to discuss these plans, and it was generally agreed that this major problem of settlement had so far received relatively little adequate systematic and intensive study.

The Canadian situation was considered to be the most important, at least for the time being. Into some of the undeveloped sections of the Dominion a flood of settlers has been steering, while other districts have been left practically waste. Some social and racial groups are pushing back the frontier, others are being drawn into the cities. Various reasons were attributed. It was suggested that only inferior land remained for the newcomers, or that it was more economical to improve the utilization of the lands now occupied than to pioneer the new regions. It was contended also that the pioneer spirit was dying out; that it had passed in the Anglo-Saxon while it remained in the French-Canadian; that men and women were no longer willing to accept the hardships of frontier life.

For some time a survey of this problem, first outlined by Dr. Isaiah Bowman, director of the American Geographical Society of New York, engaged the attention of committees of the National Research Council, the Social Science Research Council, the American Geographical Society and a number of Canadian scholars, who conferred with the representatives of the other bodies.

The following compose the committee of the American Geographical Society:

Dr. Frederick Merk, professor of history, Harvard University, *chairman*.
Dr. O. E. Baker, senior agricultural economist, U. S. Department of Agriculture.
Duncan McArthur, professor of history, Queen's University.
Dr. W. J. Rutherford, dean of the school of agriculture, University of Saskatchewan.
Dr. Kimball Young, professor of sociology, University of Wisconsin.
W. L. G. Joerg, American Geographical Society, *secretary*.

Associated with Dr. Mackintosh on the committee to study the Canadian phase are:

Dean W. J. Rutherford, *chairman*.
Professor D. A. McArthur, *vice-chairman*.
Professor Chester Martin, University of Toronto.
Professor D. A. MacGibbon, University of Alberta.
Professor C. A. Dawson, McGill University, Montreal.
Professor R. W. Murchie, University of Manitoba.

This committee plans to cooperate with the Dominion and provincial governments, the universities of western Canada and with individual investigators to avoid duplication and to facilitate the work.

THE CORNELL CENTER FOR RESEARCH IN BIOPHYSICS

THE General Education Board has given to Cornell University the sum of $1,500,000 for assistance in the development of a graduate center of scientific research in the border fields between the biological and physical sciences. The gift is conditional upon the

collection by the university of a similar amount by June, 1930. This is the first step toward the realization of a plan which will require for its completion the addition of approximately $9,000,000 to the resources of the university. About $1,000,000 will be appropriated for a new building for graduate instruction and research. The remainder will be used for the endowment of the teaching staff and equipment. It has been decided to undertake both the academic and financial development in three stages requiring capital amounts of $3,000,000 each. It was the opinion of the experts who made the survey which resulted in this action that the development of modern science required the establishment of divisions covering border fields of inquiry, and that Cornell University presented an excellent opportunity for this development.

In making the announcement President Farrand said:

> The formulation of the plan is based primarily on the outstanding contributions of the college of agriculture to biological science. The general field which is to be studied, the middle ground between the physical and biological sciences, is one of the most inviting areas open to investigation. While both groups of scientists have each been making additions to knowledge of great significance in their respective sciences, they have been coming face to face with problems which demand close collaboration.
>
> The study of the physical sciences has been comparatively independent of the help of the biologist, but biological research is more and more leading into regions where further investigation becomes a problem for the physical scientist.
>
> Thus far there has been too little organized effort on the part of those working in either of these two great fields to collaborate in applying the methods of the physical sciences to the study of biological phenomena, and, what is more important, in applying physical principles to the interpretation of those phenomena.
>
> On the one hand, the biologist has found his time so occupied with his own researches that he has had little opportunity to study and assimilate the essentials of the underlying sciences of chemistry, physics and mathematics that are applicable to his problems. On the other hand, the student of physical sciences, especially during the last two decades, has found his own problems of atomic structure and the nature of matter so absorbingly interesting that he has given little thought to his obligation to collaborate with the biologist in studying those problems which are of obvious interest to both groups.
>
> Our plan involves the strengthening of our provisions for the basic sciences of physics, of chemistry and of biology in its various phases, with the particular purpose of coordinating and concentrating the attack on the border fields between the sciences. It is proposed to crown this coordinating development by creating a center for research in general physiology which shall embrace and emphasize the fields of biophysics and biochemistry and the varied aspects of the problem of organic function.
>
> This constitutes one of the most important opportunities in the history of Cornell and should engage the enthusiastic support of its friends in bringing the plan to successful operation.

THE THIRTEENTH SUMMER MEETING OF THE AMERICAN MATHEMATICAL ASSOCIATION

ACCORDING to an announcement in the journal of the association the thirteenth summer meeting will be held at the University of Colorado, on Monday afternoon and Tuesday morning, August 26–27. A program of interest to college and university teachers of mathematics is being prepared. It will include the retiring presidential address of Professor W. B. Ford. Immediately following this meeting and lasting for the remainder of the week, there will be a colloquium and summer meeting of the American Mathematical Society. The colloquium will consist of a series of five lectures, beginning Tuesday afternoon, by Professor R. L. Moore, of the University of Texas, on "Point-set Theory." On Thursday afternoon, Professor Virgil Snyder will give his address as the retiring president of the society on "The Problem of Cubic Variety in Four-way Space."

This meeting will offer an unusual opportunity to combine mathematical activities with a pleasant outing. Boulder is a beautiful city with a population of about 15,000, delightfully located at the entrance to the Rocky Mountains. Since it is not a summer resort, prices are reasonable. A fifteen minutes' walk from the campus takes a person into wooded canyons and foothills; an auto ride of less than one hour, into the high mountains. Boulder is one and one half hours' bus ride from Denver, which has excellent railroad connections with all parts of the country.

Wednesday will probably be devoted to an all-day excursion into the elevated and scenic Estes Park and Rocky Mountain Park region. Other short trips and typical western outings are being planned. The committee on arrangements is making thorough preparations for entertaining visitors, and will be glad to assist any who may wish to spend a part or all of their summer in the beautiful Rocky Mountain region. The University of Colorado maintains a recreation office during the summer session; this is to be continued during the meetings, and the director, Professor C. A. Hutchinson, places the resources of his bureau at the services of members and their families. He will be glad to give any information and advice concerning board and lodging to members who may consider bringing their families earlier than the meeting to enjoy a prolonged stay in Colorado, or who

may wish to stay after the meeting. Addresses and prices of rooms or furnished houses in the city, or of cabins in the mountains, may also be secured from Professor Hutchinson. Lodging for the period of the meetings will be provided in the fraternity and sorority houses at a price not to exceed $1.00 per night per person, except that a limited number of single rooms will be available at $1.25 per night per person.

The full program of the association meeting will be sent to the members in July with a post card for making reservations.

SCIENTIFIC NOTES AND NEWS

CHARLES FRANCIS BRUSH, of Cleveland, distinguished as the inventor of the arc light, died on June 15 at the age of eighty years.

DR. NATHANIEL LORD BRITTON has asked to be relieved from his duties as director-in-chief and secretary of the board of managers of the New York Botanical Garden. Since 1896, the date of the establishment of the garden on the initiative of Dr. Britton, he has served as director, and now having reached the age of seventy years desires to spend more time in research in tropical America. His resignation as director will be considered by the board of scientific directors, of which Professor R. A. Harper is chairman, while his resignation as secretary will be taken up by the board of managers, of which Professor Frederic S. Lee is president.

ON the occasion of the retirement of Dr. William H. Welch, of the Johns Hopkins University Medical School, from the presidency of the Maryland State Board of Health, with which he had been connected for thirty-one years, Governor Ritchie spoke of "the outstanding service which Dr. Welch has rendered to Maryland through personal interest, wise counsel and the time and attention he has given so generously and over so long a period to the State Department of Health." Dr. Thomas S. Cullen, professor of clinical gynecology in the Johns Hopkins University, will succeed Dr. Welch.

A PLAQUE of David Starr Jordan, chancellor emeritus of Stanford University, has been made by Carleton B. Angell, to be hung in one of the halls of the new museum building of the University of Michigan. At a dinner last year in Tokyo of Stanford graduates, under the chairmanship of Yakanosuke Fukuita, of the class of 1904, at which about sixty Japanese were present, it was decided to secure and forward to Dr. Jordan a work of art symbolic of his efforts for world unity and peace. This gift arrived in due time. It is mainly of bronze with gold and silver overlays and consists of the figure of a dove, almost life-size, perched on an old broken temple-roof tile out of which a plant has grown. The piece is accompanied by a teak-wood stand for its suitable display.

PROFESSOR EDWARD WILBER BERRY, professor of paleontology in the Johns Hopkins University, has been appointed dean and provost in succession to Dr. Joseph S. Ames, whose election to the presidency was announced last week.

YALE UNIVERSITY has conferred the degree of doctor of science on Dr. Arthur Holly Compton, professor of physics at the University of Chicago, and on Dr. William Hallock Park, professor of bacteriology and hygiene in the University and Bellevue Medical College of New York University. The doctorate of laws was conferred on William Henry Carmalt, a member of the faculty of the Yale School of Medicine from 1876 to 1907. Richard Thornton Fisher, director of the forest school of Yale University, was made master of science.

DEGREES conferred by New York University include the doctorate of laws on Dr. Robert A. Millikan, director of the Norman Bridge Laboratory of Physics of the California Institute of Technology; the doctorate of science on Dr. William H. Wilmer, director of the Wilmer Ophthalmological Institute of the Johns Hopkins University, and the doctorate of commercial science on Mr. James H. McGraw, the publisher.

DR. WILLIAM T. BOVIE, professor of biophysics at Northwestern University, has received the honorary degree of doctor of science from Albion College. President John L. Seaton, in conferring the degree, characterized Dr. Bovie as "a brilliant teacher of biophysics and a leader in scientific research, a recognized authority on the therapeutic effects of light, and an inventor of electrical instruments destined to revolutionize the practice of surgery."

DR. KIRTLEY F. MATHER, professor of geology and chairman of the department, Harvard University, received the honorary degree of doctor of science from his alma mater at the ninety-eighth annual commencement of Denison University. Dr. Mather was commencement speaker, his topic being "The Quest Eternal."

THE doctorate of laws was recently conferred on Dr. E. W. Allen, chief of the office of experiment stations, U. S. Department of Agriculture, by the University of Missouri. Dr. Allen has for many years had charge of the administration of the federal laws (Hatch, Adams and Purnell Acts) providing for agricultural research at the state agricultural experiment stations and of the activities of the office of experiment stations in promoting such research.

DR. ELLERY H. HARVEY, director of the laboratories of Montgomery Ward and Company, Chicago, had conferred upon him on June 12 by Bucknell University the degree of chemical engineer.

HONORARY doctorates were conferred at the fifty-fifth commencement of Purdue University on Harry T. Cory, of Hermosa Beach, California, hydraulic engineer; on Professor George Spitzer, chemist, a member of the dairy department of the Purdue Agricultural Experiment Station, and on Professor Harold B. Smith, of the Worcester Polytechnic Institute.

PROFESSOR JAMES H. BREASTED, of the University of Chicago, was awarded the Rosenberger medal at the university's one hundred and fifty-fifth convocation. The medal is given annually to the person connected with the university who has performed the greatest service "through research, in authorship, in invention, for discovery, for unusual public service or for anything deemed of great benefit to humanity."

Nature reports that the Linnean Society of London held its anniversary meeting at Burlington House on May 24, under the presidency of Sir Sidney F. Harmer. The following were elected officers of the society for 1929–30: *President,* Sir Sidney F. Harmer; *Treasurer,* Mr. H. W. Monckton; *Zoological Secretary,* Dr. G. P. Bidder; *Botanical Secretary,* Mr. J. Ramsbottom. The Linnean gold medal for 1928–29 was handed to Dr. J. B. Hubrecht, counsellor of the Netherland Legation and son of the famous zoologist, for conveyance to Professor Hugo de Vries, to whom the medal had been awarded in recognition of his great contributions to the advancement of botanical science. In presenting the medal, the president, Sir Sidney Harmer, paid tribute to the influence de Vries has had on biological thought since his thesis in 1870, particularly by his work on osmotic pressure, his theory of intracellular pangenesis and his long series of studies on experimental evolution.

DR. J. J. PFIFFNER, chemist, formerly of Parke, Davis and Company, has been appointed to the resident staff of The Biological Laboratory of the Long Island Biological Association at Cold Spring Harbor. For the present he will collaborate with Dr. W. W. Swingle, of the Biological Laboratory and of Princeton University, and with Dr. R. G. Harris, director of the Biological Laboratory.

DR. JAMES G. MCALPINE, for the last five years bacteriologist of the experiment station at Connecticut Agricultural College, has resigned.

DR. ELLICE MCDONALD, of the University of Pennsylvania, has been appointed secretary of the local section officers of the American Chemical Society. He is in charge of coordination of programs of the seventy-eight sections of this society and has the arrangements to make for lecturers who are planning to tour. The first tour will be that of the president of the society, Dr. Irving Langmuir, in October. Those desirous of giving lectures before the sections of the American Chemical Society should communicate with Dr. McDonald, 133 South Thirty-Sixth Street, Philadelphia, Pa.

JOSEPH C. GILMAN, associate professor of botany in the Iowa State College, has been appointed secretary of the Iowa Academy of Science to replace Professor P. S. Helmick, Drake University, who has resigned.

AFTER July 1 all manuscripts intended for *The Anatomical Record* should be sent to the editor, Dr. Edward A. Boyden, department of anatomy, School of Medicine, University, Alabama.

THE *Journal* of the American Medical Association reports that Professor Richard M. Pearce, general director of the division of medical education of the Rockefeller Foundation, has arrived in Tokyo where he will stay for more than a year and will lecture on biology at the medical college of Keio University, Tokyo. A special laboratory has been given him in the new building of the institute of medical zoology and preventive medicine. A large part of the new buildings were recently erected from funds contributed by the Rockefeller Foundation.

ARTHUR DAVIS, for twenty years chief engineer and director of the U. S. Reclamation Service, arrived in Moscow on June 13. He has been invited by the Soviet Union to act for two years as chief consultant engineer, to take charge of all irrigation in middle Asia, which is the most important economic region, as cotton plantations are concentrated there.

DR. THOMAS S. BAKER, president of the Carnegie Institute of Technology, sailed for Europe on June 13 to consult scientific men in Europe in regard to developments at the institute. One of his objects is to establish at the institute a coal research laboratory.

DR. ALEŠ HRDLIČKA has left Washington for the summer to conduct his second expedition to Alaska, taking with him as assistant Dr. Maly, of Prague.

DR. JAMES BATCHELLER SUMNER, who has been made professor of biological chemistry at the Ithaca division of the Cornell Medical School, has been granted leave of absence for the first term of 1929–30 and will leave for Stockholm in June to spend the time in the laboratory of Professor Hans von Euler.

DR. LUCIANA JACQUES DE MORAES, mining geologist of the Brazilian Geological Survey, is visiting the

United States. During August he plans to join Dr. Resser in Montana to study the Pre-Cambrian rocks and the recent Algae deposits.

DR. F. A. E. CREW, lecturer on animal genetics and director of the animal breeding research department of the University of Edinburgh, has sailed from Southampton to attend the annual conference of the Canadian Society of Technical Agriculturists. He will address the conference at Winnipeg.

DR. PHILIP A. SCHAEFER, professor of biological chemistry, of Washington University School of Medicine, addressed the St. Louis University Sigma Xi Club on May 22, on "Some Biological Aspects of Oxidation."

DR. FREDERICK GEORGE DONNAN, professor of general chemistry at University College, London, gave the commencement address at the Johns Hopkins University. He spoke on the relation of chemistry to modern life.

DR. CONWAY MACMILLAN, formerly head of the department of botany of the University of Minnesota and state botanist of Minnesota, died at Minneapolis on June 5 at the age of sixty-two years.

THE death is announced at the age of seventy-eight years of Thomas Nesmith Brown, an entomologist and horticulturist of Uniontown, Pennsylvania. During more than forty years Mr. Brown built up a large private collection of insects, becoming known through correspondence and exchange to coleopterists and lepidopterists in many parts of the world. He was a member of the American Association for the Advancement of Science.

AN Associated Press despatch states that permission for Dr. Roy Chapman Andrews to conduct another expedition into the Gobi desert region of China and for the shipment to the United States of the collection of fossils and other objects collected in his 1928 expedition will be given by the Chinese government. Dr. C. C. Wu, Chinese minister at Washington, has made public the decision of the Chinese government after the question had been discussed with him by Henry L. Stimson, Secretary of State, at the request of Dr. H. Fairfield Osborn, president of the American Museum of Natural History in New York City, under whose auspices the Andrews expeditions have been conducted. At the same time, in order to promote research knowledge, the Chinese government has given orders that some 35 cases of fossils, collected during the 1928 expedition and which have been held up in China, be allowed to be shipped to New York.

THE Boyce Thompson Institute for Plant Research at Yonkers, New York, which was completed and dedicated in the fall of 1924, is to put up new buildings costing about $400,000, more than doubling the total space of the present laboratories. This will give adequate space to increase the present scientific staff from thirty-seven to sixty members and is being done to meet the actual growth of the institute's work. The excavations will start on September 1. The overcrowding of the laboratories has been partly due to the development of research projects financed by outside organizations or individuals. An important addition to the scientific staff followed a recent grant of $20,000 a year for five years from the Frasch Fund for Research in Agricultural Chemistry. Outside problems have been undertaken for other firms and individuals but many investigations asked for have been refused for lack of laboratory space. Such a building, situated in the midst of about 700 acres of land devoted to an arboretum, experimental fields and greenhouses, occupying in all 400 acres, is expected to take care of the growth of the institute for a number of years to come.

GROUND was broken on June 16 for the new buildings of the New York Hospital-Cornell Medical College Association's new buildings at York Avenue and East Sixty-ninth Street. The site of the new medical center includes the property from Sixty-eighth to Seventy-first Streets between York Avenue and Exterior Street and is just north of the Rockefeller Institute for Medical Research. Mr. Edward W. Sheldon, president of the board of governors of New York Hospital, turned the first spadeful of earth.

THE *Journal* of the American Medical Association reports that in a statement to the board of managers and medical staff of the Presbyterian Hospital, Dr. Arthur Dean Bevan, chairman of the department of surgery, reviewed the close relation which has long existed between Rush Medical College, the Presbyterian Hospital and the University of Chicago, as well as the great service which these institutions have rendered in the care of the sick and the training of physicians. The future will bring a greater opportunity, but to meet the demands, Dr. Bevan believes that there should be additions to the plant and a reorganization of the various medical, surgical and special departments of the Presbyterian Hospital and the medical school of the university. Among the additions which were considered necessary are a clinic building, a hospital for children and orthopedic patients, a maternity pavilion, a larger power plant and nurses' home, increased dispensary facilities and a remodeling of the laboratory building at Rush, all of which, it is estimated, would require at least $5,000,000. As evidence of their faith in the future of these institutions, Dr. and Mrs. Bevan have offered to create, if such improvements are undertaken, an irre-

vocable trust of $1,000,000 to be devoted to this medical service and medical education.

WE learn from the London *Times* that a delegation of professors of the faculty of science of the University of Geneva on May 29 deposited a wreath on the tomb of Sir Humphry Davy, who died in Geneva on May 29, 1829, fifteen hours after his arrival from Rome. He was buried in the Plainpalais cemetery, where the town granted a free burial place for ninety-nine years. The concession was renewed some years ago by the Royal Society until 1965. Lady Davy expressed her gratitude in a letter which presented the university with a sum which has made it possible ever since to award the Davy prize each year for the best study by students of the university in physics, chemistry, mineralogy, botany or geology.

A BRONZE portrait bust of the late Sir Clifford Allbutt, Regius professor of physics at the University of Cambridge from 1892 to 1925, was unveiled by Sir James Crichton-Browne, in the Allbutt Library of the medical school, on May 18. Lady Allbutt, the donor of the portrait, was at the ceremony. The Allbutt Library occupies the room formerly known as the Kanthack Library, which has been removed to the new pathological department.

JOHN D. ROCKEFELLER, JR., has presented to the trustees of the Mount Desert Island Biological Laboratory the Karst property opposite the laboratory dining hall at Salisbury Cove. The house will be occupied this summer by the family of Dr. E. K. Marshall, Jr., professor of physiology in the Johns Hopkins University.

THE Association to Aid Scientific Research by Women announces its continued support of the American Woman's Table at the Zoological Station at Naples for the years 1929–1930 and 1930–1931. Applications for the use of the table must be made to the secretary of the Association, Mrs. Samuel F. Clarke, Williamstown, Massachusetts. There is no required limit of occupancy, but it is always hoped that a worker can arrange to stay for three months. No financial help is given—merely the opportunity to occupy a research room; but the American Woman's Table is fully equipped with apparatus so that none need be carried by the student. Since no instruction is given the table is only awarded to those who are ready to carry on independent investigation, and preferably to those who have a definite piece of work in mind which can best be carried on by the facilities offered at Naples. The American Woman's Table was first supported in 1898 on the suggestion of Dr. Ida Hyde, one of the first American women to study there, and as a courtesy to Dr. Dohrn on the twenty-fifth anniversary of the opening of the laboratory. With the exception of one war year, and a few years at a later period during reorganization of the support of the station, the table has been continuously maintained by the Association to Aid Scientific Research by Women.

THE response to the preliminary announcement issued in connection with the fourth World Poultry Congress, which is to be held at the Crystal Palace in July, 1930, has been, according to the London *Times*, so substantial that the accommodation will be severely taxed. The international response has been exceptionally gratifying, and, though it is not possible at present to state the number of countries that will participate, it is clear that the event will attract a great many visitors. Active preparations are being made in Canada and in the United States, as has already been stated; and in France, Holland and Germany national committees have been set up. The Irish Free State Minister of Agriculture has appointed a committee to advise the Department of Agriculture with regard to that country's representation at the congress, and particulars can be obtained by intending exhibitors from the secretary, World Poultry Congress Committee, Department of Agriculture, Government Buildings, Dublin. The British national exhibit will be planned under the guidance of the Department of Overseas Trade.

UNIVERSITY AND EDUCATIONAL NOTES

COLONEL ROBERT W. STEWART, of Chicago, former chairman of the board of directors of the Standard Oil Company of Indiana, has given $200,000 to Coe College for a memorial library in honor of his father and mother.

DR. ROBERT G. SPROUL, vice-president and comptroller of the University of California, has been elected president to succeed Dr. W. W. Campbell, who will retire on July 1.

DR. KATHARINE BLUNT, professor of food chemistry at the University of Chicago, has been appointed president of the Connecticut College for Women at New London.

DR. LEWIS H. WEED has retired as dean of the faculty of medicine of the Johns Hopkins University. He will remain head of the department of anatomy.

DR. RICHARD G. TYLER, of the Massachusetts Institute of Technology, has been appointed professor of sanitary engineering and dean of the college of engineering at the University of Washington.

FREDERICK V. LOFGREN, instructor in the college of pharmacy at the University of Washington, has ac-

cepted a position as dean and professor of the college of pharmacy at Valparaiso University.

DR. OTTO FREDERIC KAMPMEIER, professor of anatomy at the University of Illinois College of Medicine, has been appointed head of the department of anatomy to succeed the late Professor Victor E. Emmel.

DR. T. FRANKLIN SIBLY, the geologist, principal of the University of London, has been elected vice-chancellor of the University of Reading, in succession to Dr. W. M. Childs, who is retiring in September.

DISCUSSION

GIFT TO DOWN HOUSE OF THE ORIGINAL LETTERS OF CHARLES DARWIN TO FRITZ MÜLLER

AFTER a year and a half of correspondence Professor Osborn has succeeded in purchasing from the Müller heirs in São Paulo, Brazil, the originals of the entire series of letters from Charles Darwin to Fritz Müller, chiefly written from Down House during the period from August 10, 1865, to January 4, 1882. These precious letters, which are now on their way to the American Museum of Natural History by registered mail, have been lying in the safe of Dr. C. T. Stewart, president of Mackenzie College, São Paulo, Brazil, and were reported in December, 1928, by Director L. V. Coleman, of the American Association of Museums, as being in excellent condition. The find was rather surprising since we had been informed "that one of the Müller heirs had successfully carried out his intention of taking all the Müller correspondence to Germany some time ago."

At the time Francis Darwin was preparing the life of his father he secured from the Müller heirs very accurate typewritten copies of all these letters, from which he made more or less copious extracts for his four biographic volumes. The series of inquiries which Darwin addressed to Müller cover a very great variety of subjects but chiefly relate to the problems of mimicry and to the cross and self-fertilization of plants. Despite Darwin's very delicate health they are written with very great care. After the first letter of inquiry each succeeding letter opens with an enthusiastic word of appreciation. The letters are fifty-eight in number, and by comparison in the American Museum with Francis Darwin's "Life and Letters" (edition 1896) it has been found that the series contains the August 10, 1865, letter with which Charles Darwin opened the correspondence. Seven more of the Müller letters are quoted in whole or in part in Volume II of the "Life and Letters," and thirty letters are quoted in whole or in part in Francis Darwin's "More Letters of Charles Darwin" (edition 1903). Thus of the fifty-eight letters secured for the memorial collection in Down House, which was opened on June 7 as a national shrine to the great naturalist, there are thirty-eight wholly or partly published and twenty still to our knowledge unpublished. Of the great German naturalist with whom Charles Darwin had this long correspondence, Francis Darwin writes, "My impression is that of all his unseen friends Fritz Müller was the one for whom he had the strongest regard." A biographical note on Fritz Müller is given on page 382 (Volume I) of "More Letters of Charles Darwin." His full name was Dr. Johann Friedrich Theodor Müller and he was residing in Blumenau, Sa. Catharina, South Brazil, when Darwin was writing to him.

HENRY FAIRFIELD OSBORN
AMERICAN MUSEUM OF NATURAL HISTORY

A CASE OF ACCIDENTAL PARASITISM

DURING the spring of 1927 Dr. Parke H. Simer, of Illinois Wesleyan, was at Money, Mississippi, on the banks of the Tallahatchie River collecting parasites. This river joins the Yalobusha to form the Yazoo River, which empties into the Mississippi near Vicksburg. All the Cestodaria secured were kindly turned over to me, and all these were taken with but a single exception from members of the Catostomidae, or suckers. One new species, *Glaridacris confusus*,[1] presented some interesting infection data, so unusual, in fact, that it seems wise to present this note separately.

Glaridacris confusus has been reported from several localities and hosts. *Ictiobus bubalus,* the small-mouthed buffalo fish, harbored this parasite in the Rock River, Illinois, and in the Mississippi River near Fairport, Iowa. Dr. Simer collected this parasite from the same host in the Tallahatchie River as well as from several undetermined Ictiobus sp., and *Dorosoma cepedianum,* the gizzard shad. The parasite is by far one of the most common in this region, being present in twenty-five of thirty-four Ictiobus examined, or 73.5 per cent. In addition it has been frequently encountered in Illinois and Iowa from the same host. Yet it is found but once in *Dorosoma cepedianum.*

No light can be gleaned from the parasite itself concerning this infection since we do not know any of the stages in its life history. Let us therefore examine this unusual host, *Dorosoma cepedianum.* The most striking feature appears to be that the two hosts of this parasite, the buffalo fish and the gizzard shad, belong in two widely separated families, Catostomidae and Dorosomidae (Clupeidae), respectively. Accord-

[1] G. W. Hunter, III, "New Caryophyllaeidae from North America," in press.

ing to Hubbs[2] these belong in the same order, Malacopterygii, although the older workers placed these groups in different orders, Eventognathi and Isospondyli. Without going into the "pros and cons" of this question it is evident from the disposition of these families into separate orders that there are considerable differences between the two, both morphologically and physiologically. In the second place this constitutes the first record of infection of the gizzard shad by a Cestodarian parasite. All the other thirty-nine species of Caryophyllaeid parasites are found in members of the Catostomidae, Siluridae or Cyprinidae. Furthermore the infection is unusual because this fish normally harbors but few parasites. The author in collaboration with Essex examined 107 gizzard shad in 1925 from the Rock and Mississippi Rivers (the latter at Lake Pepin, Minnesota) and did not find a single infected specimen.[3] This dearth of parasitic fauna was explained by the fact that "The feeding habits of the gizzard shad seem to be such as to preclude the acquiring of an extensive parasitic fauna. Since it feeds largely on vegetable débris at the bottom of streams and lakes, very seldom ingesting animal food, there is little opportunity for parasites which have an extremely complex life cycle to find in it a suitable host." However, Van Cleave[4] in an examination of over three hundred gizzard shad finds a decided periodicity of infection by Acanthocephala; his examinations, being seasonal, show a decrease of these parasites during the summer months which explains why we did not find any Acanthocephalid infection. Dr. Simer examined fourteen of these from the Tallahatchie River. Only six possessed what a superficial examination classed as possible Cestodarian infection. Of these only one actually proved to harbor *G. confusus*, the other being plerocercoid larvae and Acanthocephala. By combining the records we have evidence of one case of infection by a Cestodarian, *G. confusus*, in over four hundred and twenty fish examined, or 0.23 per cent. From the statistical standpoint the evidence is overwhelming that this parasite is not naturally found in this host.

Dr. Simer was in Mississippi during the spring of 1927 when the flood waters were near their peak. This meant that the entire biological balance was upset, for both fishes and fish food were not only disturbed but even swept away. It is but a step further to visualize the gizzard shad, *Dorosoma cepedianum*, eating infected intermediate hosts containing *G. confusus* or securing direct infection if this method prevails, and thus becoming accidentally infected by this parasite. Surely the evidence at hand points to this as the only logical explanation.

GEORGE W. HUNTER, III
BIOLOGICAL LABORATORIES,
RENSSELAER POLYTECHNIC INSTITUTE

[2] C. L. Hubbs, "A Check-list of the Fishes of the Great Lakes and Tributary Waters, with Nomenclatorial Notes and Analytical Keys," Univ. of Mich. Mus. Zool., Misc. Pub. No. 15, 77 pp., 1926.

[3] Essex, H. E., and G. W. Hunter, III, "A Biological Study of Fish Parasites from the Central States," *Trans. Ill. St. Acad. Sci.*, 19: 151–181, 1926.

[4] H. J. Van Cleave, "Seasonal Distribution of Some Acanthocephala from Fresh-water Hosts," *Jour. Parasit.*, 2: 106–110. 1916.

CEPHENOMYIA SP. KILLING DEER

DUE to the severity of the winter and the excessive snowfall in the higher mountains the black-tailed deer, *Odocoileus hemionus*, of this region have been forced into the valleys, and have been fed regularly on the feed grounds with the cattle or on separate feed grounds or in feed racks. In the middle of January they began to appear on the lower foothills and occasionally in the fields where they visited the hay stacks. Regular feeding was started in early February and continued until they started moving back into the hills. The feed grounds below Gunnison were located at the Hillside School, about three miles below Gunnison, and at regular intervals down the river.

When the deer first came down they were practically all poor and weakened. Feeding restored their vitality on all grounds except at the Hillside School. On this ground it was noted that the young deer and some of the older failed to recover strength. During the latter part of February some of the young died. In early March the death-rate became much higher, and at the present time more than sixty deer have died. Autopsies showed conditions quite normal except in the head, where the larval stage of *Cephenomyia* sp. were found in abundance. Clusters of the larvae were found hanging attached to the nasopharynx in such masses as to almost completely stop the nasal passages. In one autopsy fifty-four larvae were taken. In this deer the tissues of the lower nasal passages were highly inflamed, and in the upper left sinuses infection had set in and had extended to the left lobe of the brain on which there was also a hemorrhage. These larvae ranged in size from a half inch long to mature larvae.

No early symptoms of infection were visible except a general weakness and emaciation. In the deer captured for the local park extreme restlessness was observed for twenty-four hours before death. In these cases (seven head) the animals died in what seemed to be extreme agony with the head severely drawn back toward the shoulders. On the feed grounds other than that at Hillside there have been only occasional deaths.

Although the deer have been fed in previous years in this region there has been no unusual number of deaths among the herds. Pierce[1] states the goat head bot is native in California on the deer but that there is little evidence of its effect. Herms[2] lists the genus *Cephenomyia* as being present in the black-tailed deer, *Odocoileus columbianus*. Through the courtesy of Dr. Sam McCampbell, deputy state entomologist of Colorado, Dr. Bourne, of the veterinary department of the Colorado Agricultural College, and Dr. T. D. A. Cockerell, of the University of Colorado, the identification of these larvae has been confirmed as being those of *Cephenomyia* sp.

The present rate of destruction of the deer from this cause makes the problem of game conservation in this region a serious one.

C. R. WALKER

WESTERN STATE COLLEGE OF COLORADO

SOLAR ECLIPSES

IN the issue of SCIENCE for May 24, 1929, page x, it is stated that Professor John A. Miller, of Swarthmore College, has just observed his seventh total solar eclipse, all seven having been clear. It is further stated that "no other astronomer has seen as many, though one has been to nine and another to eight." In this latter connection may I draw attention to the record of David Todd, professor emeritus of astronomy at Amherst College, who has been to the following eclipses: 1878, July 29, Texas; 1887, Aug. 19, Japan; 1889, Dec. 22, West Africa; 1896, Aug. 9, Japan; 1900, May 28, Tripoli, Barbary; 1901, May 18, Singkep, Dutch East Indies; 1905, Aug. 30, Tripoli, Barbary; 1914, Aug. 21, Russia; 1918, June 8, Florida; 1919, May 29, Brazil; 1925, Jan. 24, New York. Though the above list of attendance at eclipses is longer than that of any other astronomer, eleven in all, the majority were obscured by clouds, only four having yielded entirely successful results.

MILLICENT TODD BINGHAM

SCIENTIFIC BOOKS

Colour and Colour Theories. By CHRISTINE LADD-FRANKLIN. New York, Harcourt Brace and Co. 1929.

THE contributions of Mrs. Ladd-Franklin to color theory are familiar to all psychologists, but her work has never received adequate recognition from physicists, possibly for the reason that most of her papers have appeared in psychological magazines. These papers are now brought together in a volume of the International Library of Psychology, Philosophy and Scientific Methods.

Mrs. Ladd-Franklin first developed her theory of vision in 1892. She reported its essential features at the Psychological Congress held in London and published it in detail in the *Zeitschrift für Psychologie* in the same year. An English account appeared in *Mind* during the following year. These papers and her article on "Vision" in Baldwin's Dictionary (1902) are reprinted in full, together with several later articles which discuss specific visual phenomena and reply to various objections raised against the hypothesis.

The problems and difficulties of explaining color vision are too well known to need more than brief allusion. The three-component theory of Young and Helmholtz ignores yellow, which psychologists regard as a primary visual phenomenon. The six-component theory of Hering and others admits yellow, white and black as primary phenomena, but assumes that red and green result from antagonistic retinal processes, whereas actually they are not complementary. It is not surprising that physicists are inclined to favor the Helmholtz hypothesis and physiologists the Hering hypothesis, while psychologists find objections to each. Mrs. Ladd-Franklin's theory meets the objections to both these explanations by assuming that color vision originated first of all in a blue-yellow differentiation of the primitive achromatic retinal processes and that later the yellow component differentiated into green and red processes. It should be noted that this interpretation has found favor with a large number of psychologists, though her explanation of the black sensation is not so generally accepted. In the present volume are included a number of shorter papers by recent writers who have adopted the Ladd-Franklin theory, in which the black sensation and other visual problems are treated from her standpoint.

The book is provided with many excellent diagrams and color charts and has a glossary of technical visual terms. The exposition is clear and logical. It is to be hoped that physicists and others interested in color phenomena will have their attention drawn to this alternative theory of vision, which solves many of the difficulties presented by the classical theories.

HOWARD C. WARREN

PRINCETON UNIVERSITY

Meteorology. By DAVID BRUNT. 112 pages, 19 illustrations. Oxford University Press. 1928. $1.00.

IT is a rare pleasure to find an elementary work on any science that one can unreservedly recommend. This book by an important official in the Meteorological Office, London, affords that pleasure. It

[1] D. Dwight Pierce, "Some Milk Goat Problems in California," State of Calif. Dept. of Agriculture, Special Bulletin No. 22. 1922.

[2] William B. Herms, "Medical and Veterinary Entomology," Macmillan, New York. 1923.

covers the entire range of meteorology, except the optical phenomena, about as fully, perhaps, as the average person cares to know it. There are no mathematical equations, and no attempt to discuss things that require for their elucidation this type of formal logic. Nevertheless, Dr. Brunt evidently assumes that his readers already have some knowledge and want more, for he writes as one scholar to another, and not, as so many authors of popular science do, as a romancer to blockheads.

Each of the eleven chapters is excellent, but the one that treats of that most difficult subject, the "Origin of Cyclonic Depressions," is so exceptionally good as to deserve especial mention.

In speaking of humidity Dr. Brunt refers, as does nearly every one else, to "the maximum amount of water-vapor which air can take up." Perhaps he might be willing to explain, in some future edition, that the only merits of this expression are its hoary age, general usage and convenience; that really the air is not a sort of sponge nor in any way essential to evaporation, and that after all it is the space and not the air that becomes saturated.

There is no book on meteorology that one could recommend more heartily than this to the general reader.

W. J. HUMPHREYS

U. S. WEATHER BUREAU

SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPARATUS FOR THE DETECTION OF SUBSTRATUM COMMUNICATION AMONG TERMITES

THE theory that termites might communicate with each other by means of substratum vibrations usually not audible to the human ear led to the construction of the apparatus described below. A more extensive paper on the subject of termite communication will appear later, but it is thought that an account of the method of detection of substratum vibrations of termites might have a more general interest at this time.

The inside of a telephone transmitter, consisting of the carbon cup and screw to which the diaphragm is attached, was connected to four dry cells. The primary of a ten to one ratio audio transformer was connected to the microphone and batteries, while the secondary of the transformer was connected to the input terminals of an audio amplifier such as is used in radio work. An RCA Uni-Rectron AP-935 amplifier was used in this case, and an ordinary pair of head phones was connected to the output terminals

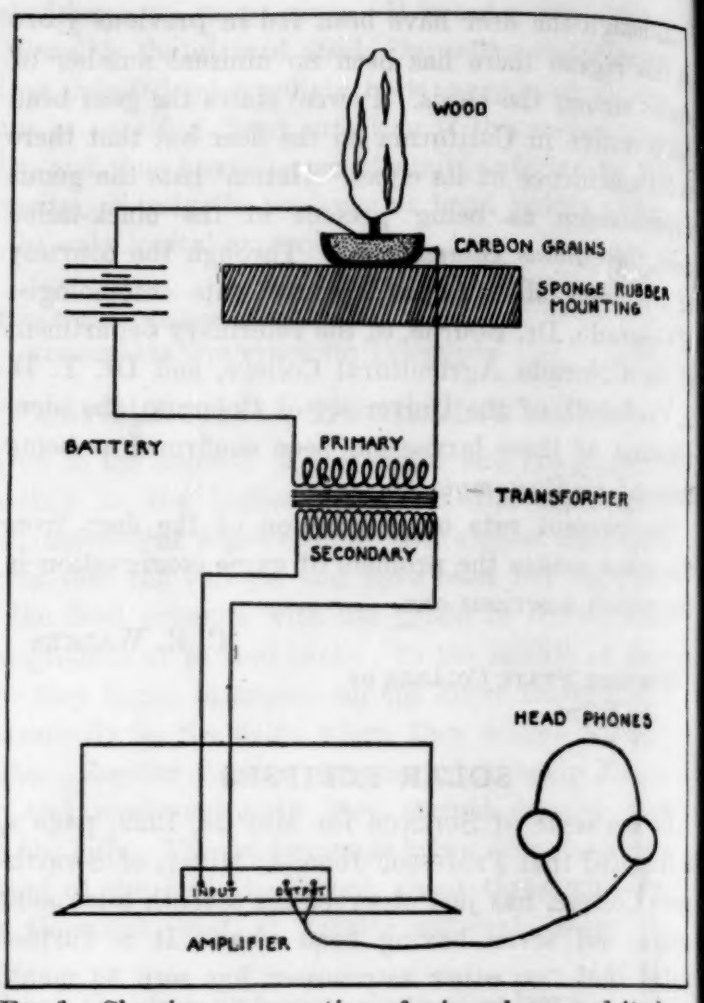


FIG. 1. Showing cross section of microphone and its base.

of the amplifier. The diaphragm was removed from the telephone transmitter and a piece of the wood inhabited by the termites was threaded on the diaphragm screw.

The termites crawling upon the wood jarred the carbon grains, thus altering the current from the dry cells. This produced a sound which was amplified to the extent that a termite walking on the wood could be heard through the head phones. It was found best to mount the microphone button and attached wood on a piece of sponge rubber in order that outside vibrations jarring the table or floor would not register on the apparatus.

After several hours of observation, some soldiers of *Reticulitermes flavipes* (Kollar) became disturbed and were thus stimulated to hammer their heads upon the wood. This performance could be plainly seen at the same time that the amplified noise produced was easily heard through the head phones. This action on the part of soldiers of *Reticulitermes flavipes* has never before been recorded to our knowledge, and we imagine that the sound would be almost impossible to hear under natural conditions.

Audible sounds made in a similar manner have been detected among several genera of *Kalotermitidae, Rhinotermitidae* and *Termitidae* before, but there has been some confusion in the literature as to whether the sounds were caused by hammer-

ing the head or by some stridulatory apparatus. Experiments conducted by the senior author, however, seem to indicate that termites hear air vibrations very poorly if at all, while at the same time they are very sensitive to substratum vibrations. This fact together with the definite proof that the head hammering produces a distinct substratum vibration tends to support the idea that these insects communicate with each other through the nest material. Probably the asymmetrical mandibles of *Capritermes* and allied genera are modified for making a substratum vibration by snapping the mandibles. As these substratum sounds are generally associated with disturbance, it is thought likely that they are utilized as symbols of danger.

The jerking motion of termites commonly observed did not register enough vibration through the substratum to be detected in the apparatus, and there seems to be no indication that this action is a method of communication by sound, although evidence points to the strong possibility that termites communicate by means of this jerking motion, possibly by means of an odor stimulation.

There is some indication reported by Dr. T. E. Snyder, of the U. S. Bureau of Entomology, that excessive substratum vibration frequently produced will deter termites from occupying certain situations. Crossties of railroads with heavy traffic and buildings occupied by cotton machinery in motion seem to be immune to attack, and the above experiments indicate the reason.

ALFRED E. EMERSON
ROBERT C. SIMPSON

UNIVERSITY OF PITTSBURGH

AN ACCURATE DROP RECORDER

SOME time ago in a brief review of the various existing drop recorders I described one model of Hainke's suction electrode type.[1] Recently at the request of a former colleague I constructed an instrument in which certain important changes were made. The resulting device was so much better than the one previously described that it may be of interest to others whose problems demand a high order of accuracy in the measurement of small flows. As will be seen by a reference to the figure[2] the instrument consists of three parts. *A* consists of the usual condom displacement chamber already described; in place, however, of the long inlet tube, I now fit a fine glass rod *R* which supports the condom thus insuring more complete emptying. *B* is the sulphate reservoir and also vacuum chamber combined, made from a

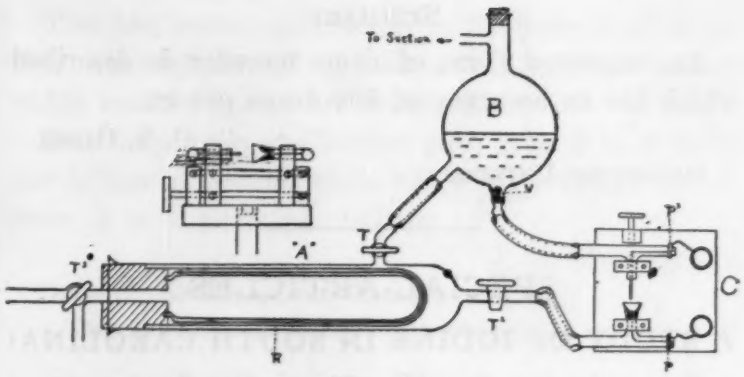


FIG. 1

250 cc pyrex flask. In the bottom tube which connects to the upper electrode is a bead valve *V* to prevent back-flow should the suction fail. When the instrument is not in use the tube leading to the electrode should be clipped off. *C* illustrates the electrodes. The top or cup of the lower one should be on a level with the middle of the displacement chamber to which it is connected. Electrical connection is made by means of a platinum wire running from the base of the cup to the binding post *P*. The upper movable or suction electrode consists of a fine platinum tube connected to its binding post P^2. To use the instrument the displacement chamber is filled with 10 per cent. sodium sulphate solution from the reservoir through the tap *T*, the exit tap T^2 being closed. In order to avoid disconnecting the animal or other source of inflow, use is made of the three-way tap T^3. Suction is now turned on, and for this purpose I personally use a filter-pump on the recorder stand worked from the laboratory compressed air. The clip is removed from the upper electrode tube and air bubbles freely in the vacuum-tube. T^2 must, of course, be closed. As the displaced fluid wells up in the cup it comes in contact with the suction electrode, momentarily making contact, which is recorded in the usual way.

Variation of the size of the drop is obtained in three ways. Firstly, by the size of the suction electrode tube; secondly, by the type of surface it takes its drop from, the larger the surface the larger the drop, hence the funnel shape of the lower electrode; thirdly, by the amount of suction used, the greater the suction, naturally, the smaller the drop. This latter, however, can not be too great unless extremely sensitive electrical recorders are used, as the contact time is correspondingly shortened.

The apparatus as demonstrated will easily give an accuracy of 600 drops per cc, using an ordinary thousand ohm telephone relay and simple signal connected through a 45-volt wireless battery. Using such a sensitive instrument as a string galvanometer with a finer electrode probably well over a thousand drops per cc could be readily recorded. Movement of the electrodes alone gives about 500 per cent. variation.

[1] O. S. Gibbs, "Drop Recorders," *Jour. Lab. and Clin. Med.*, 12: 686, 1927.

[2] I am indebted to Mr. J. G. Allen, of the cableship *John W. Mackay*, for the drawing of this instrument.

SUMMARY

An improved form of drop recorder is described which has an accuracy of 600 drops per cc.

O. S. GIBBS

DALHOUSIE UNIVERSITY

SPECIAL ARTICLES

A STUDY OF IODINE IN SOUTH CAROLINA[1]

SINCE the day Courtois made iodine from seaweed by heating it with sulphuric acid, and only a year or two later Gay-Lussac identified it as an element and gave it the name "iodine," much has been written in regard to its sources, properties and uses.

Research work in recent years indicates that the amount of iodine found in water, soil and plants from different sources varies to a considerable extent. In some sections of the United States, where there is a deficiency of iodine in the water and food, goiter is quite common, and certain troubles such as hairless pigs and big head in calves and sheep are quite prevalent. The presence or absence of iodine in a region has therefore a very important bearing on the health and happiness of the people.

Something over two years ago a project was begun by the chemistry division of the station with the idea of studying the relationship of the mineral content of feeding stuffs grown in South Carolina and the mineral content of the soils upon which they were grown. Iodine is one of several elements involved in this study.

Where the plant obtains its iodine and why plants from some sections of the country carry more iodine than others are points of considerable interest. From the analysis of many soils and waters from different parts of South Carolina it would seem that there is sufficient iodine present for the plants. The original source of this iodine is a matter for some discussion. It is likely that most of it comes from the rocks from which the soils are formed, especially in the Piedmont section.

However, there are other possible sources. It is quite possible that some is being carried through the air from the ocean along with micro-organisms and dust particles, while the coal smoke washed down by rain is another source. Rain-water at Clemson College carries some iodine. Another source is that of nitrate of soda. Caliche, the mineral from which nitrate of soda is obtained, is the greatest commercial source of iodine to-day. Several samples of nitrate of soda used in this state during the year 1928 analyzed from .027 to .054 per cent. of iodine.

[1] Contribution from the Chemistry Division of the S. C. Experiment Station.

During the years 1923 through 1927 there was sold in South Carolina annually an average of ninety-three thousand (93,000) tons of nitrate of soda. And this state had been using this fertilizer for many years previous to this.

This would mean the addition of approximately ninety-three thousand (93,000) pounds of iodine annually to the soils of this state. The iodine in sodium nitrate is largely in the form of sodium iodate.

SOILS

In the analysis of soils less iodine is found in the first six inches, and it increases with each succeeding six inches through a depth of eighteen inches. This may be due to several causes. It has been shown that there is an evaporation of iodine from the soil. The growing plant removes a portion, while leaching by water carries some in the opposite direction.

Less iodine is found in the soils from the middle section of the state than those from the upper portion. This may be due to a difference in the soil formation, the soils from the Piedmont region being formed from granites, quartzites, gneisses, etc., which usually show considerable iodine.

There is very little data for comparison on the iodine content of soils in this section of the country. The results as found in this state are shown in the table below:

Location	No. of samples	IODINE—PARTS PER BILLION			
		0–6 inches	6–12 inches	12–18 inches	Total
State Park	36	142	246	377	765
Clemson College	15	188	419	627	1,234
Florence	45	304	508	638	1,650
Bishopville	18	185	707	1,023	1,915
Trenton	18	344	888	1,181	2,413
Gaffney	9	684	1,161	1,176	3,021

IODINE IN FEEDING STUFFS

Although there is a lack of uniformity in the iodine content of plants of the same variety, yet there is no doubt that some plants have a greater preference for it than others.

From the results of this investigation it seems that vetch, winter field pea and soy-beans run somewhat higher in iodine than the other feeds, while among the vegetables, spinach, lettuce, mustard and turnip tops are the best iodine carriers.

There are other feeds that are possible sources of iodine. A sample of fish meal and one of tankage received recently by this laboratory analyzed 1,350 and 1,000 parts per billion of iodine respectively.

The results for vegetables and feeding stuffs are given in the table below:

IODINE IN PLANTS

Feedstuffs	No. of samples	P.P.B. iodine av.
Soy-beans	48	224
Cow-peas	8	162
Oats and vetch	2	560
Vetch	6	418
Oats	44	219
Grass hay	28	150
Alfalfa	3	170
Lespedeza	1	150
Winter field pea	2	880
Clover	5	380
Johnson grass	1	350
Rye and vetch	3	429
Bermuda grass	1	100
Paspalum	1	150
Vegetables*		
Turnip, Extra Early Milan		19
Turnip roots, Early Milan		28
Lettuce		224
Lettuce		340
Lettuce, from greenhouse		54.3
Mustard		83.5
Mustard		391
Spinach		464
Spinach		100
Potato, sweet		108
Rice		44.8
Radish roots		14
Asparagus		6.7
English peas, shelled		6.04
English peas, hulls and vines		15.2
Cabbage		7.4
Cabbage		11.26
Turnip tops		66.5
Collards		94.0
Turnip, white		29.0
Turnip, rutabaga		96.0
Broccoli		68.4

*The results for the vegetables are calculated on the green sample.

IODINE IN WATER

Eight river waters in the state were analyzed, and they varied in iodine content from two to six parts per billion. The largest amount was found in the Enoree and Broad Rivers. These samples were taken in the upper part of the state.

The drinking waters, both raw and pure, from four of the largest cities in the state were analyzed. The results of the pure waters varied from 1.5 parts per billion to 3 parts per billion, while the raw waters ran from 4 to 5 parts per billion.

This loss occurs quite likely in the process of filtration whereby living organisms and organic matter which contain iodine are removed.

Two deep wells at Clemson gave from 1 to 4 parts per billion of iodine, while two spring waters varied from .5 to 2 parts per billion.

J. H. MITCHELL
DIVISION OF RESEARCH CHEMISTRY
THE CLEMSON AGRICULTURAL COLLEGE

A NEW DISEASE OF DOUGLAS FIR

DURING the fall of 1927 the writer, while engaged in scouting for larch canker, discovered a peculiarly abnormal condition of the Douglas fir, *Pseudotsuga taxifolia* (Lam.) Britt., located on a large private estate at Potowomut Neck, Warwick, Rhode Island. A considerable portion of this land originally was a sand barren, yet extensive plantings of white pine, red pine, Scotch pine, European larch and Douglas fir, together with many broad-leaf genera, have been made thereon and thousands of these trees are now in a fairly flourishing condition. This estate has been cited as one of the first as well as one of the most conspicuous examples of successful private reforestation in the east. It was donated recently to the State of Rhode Island as the Goddard Memorial Park and now constitutes a valuable part of the Metropolitan Park System.

It should be stated at the outset that Douglas fir is not indigenous to the east, although for many years it has been grown here with success as an ornamental. Its habitat is the forests of the Pacific Slope and the Rocky Mountains. In those regions it grows to enormous dimensions and constitutes one of our most valuable timber trees. Three main varieties are recognized and are known respectively as the Pacific Slope, the Northern Rocky Mountain and the Central and Southern Rocky Mountain forms.[1] The Douglas fir in the Goddard Memorial Park is apparently of the last variety. Records seem to indicate that it was grown from seed collected in Colorado. The statement has been made that the original shipment of Douglas firs to this estate

[1] George B. Sudworth. "Check List of the Forest Trees of the United States. Their Names and Ranges." U. S. D. A. Misc. circular 92, p. 28, 1927. There has long been belief among European botanists that our Douglas fir represents at least two distinct species, one ranging through the Pacific Slope region and eastward into the northern Rocky Mountain region, the other being found roughly in the central and southern Rockies. Augustine Henry and Margaret G. Flood (in Proc. Royal Irish Acad., vol. 35, sect. B; 62–99, pl. 12–14, 1920) propose to designate the Pacific Slope form as "Pseudotsuga Douglasii Carriere," and the northern Rocky Mountain form as "P. Douglasii var. caesia Schwerin"; while for the central and southern Rocky Mountains form they propose the name "P. glauca Mayr."

was the first shipment of any Douglas firs to this part of the country. Thousands of these trees from three to twelve inches or more in diameter, breast high, are to be found in this park. Those less than five inches in diameter are, for the most part, growing in pure stands and are set from four to six feet apart. The larger specimens, ranging from thirty-five to forty-five years of age, are border trees or exist in ornamental groups.

The abnormal condition referred to is conspicuous upon the older Douglas firs, and in certain portions of the park the number affected may exceed 90 per cent. Trees five inches and less in diameter, with few exceptions, exhibit little evidence of disease. So conspicuous are some of the abnormal trees that even to the untrained observer they stand out prominently from the other trees in the immediate vicinity. Among the more spectacular symptoms indicative of disease may be mentioned the pronounced resinosis. This may be exceedingly extensive and involve the lower ten to fifteen feet of the main trunk. In a number of instances observed the trunks are fairly bathed in the dry, grayish-white, glistening pitch. This pitch sometimes drips from the upper parts and hangs to the lower branches in bead-like drops or in stalactitic manner. In extreme cases, it may even flow out over the ground for a foot or more from the base of the tree. Pitch pockets may occur beneath the bark of the lower portions of the trunk and apparently may involve a considerable area of abnormal contributory tissue. Such pockets sometimes contain a half-pint or more of liquid resin. By cutting into these pockets and pressing upon the loosened bark below, one may cause the resin to exude copiously. Trunk swellings or hypertrophies may be present and give to the lower part of the tree a decidedly gouty appearance. Smaller hypertrophies often occur at the nodes on the branches, particularly the lower branches. A few of them resemble in form those sometimes observed upon coast white cedar, *Chamaecyparis thyoides* (L.) B.S.P., and known to be caused by a rust, *Gymnosporangium ellisii* (Berk.) Farl. In certain instances these swellings follow along the branch in bead-like arrangement. A close examination of the hypertrophies discloses oftentimes an exudation of pitch, though in relatively small amount as compared with the trunk exudations. Associated with the swellings are to be found, in most cases, tiny white to tawny, cup-shaped apothecia. The spore-bearing or hymenial surfaces are located inside the apothecia and are of a golden yellow to orange color. After a few days of warm rain the apothecia open and reveal these hymenial surfaces. During dry weather, however, due to the inrolling of the rims the cups become nearly closed. From a study of the morphological characters of the fungus it has been determined as a *Dasyscypha*.

It is rather significant that these fructifications occur chiefly upon the hypertrophies and not to any great extent upon the normal bark. A microscopic examination of sections from the hypertrophies of living branches discloses an abnormal number of layers of bark. Apparently they were formed as a result of the excessive activity of the phellogen. Many cell layers of the periderm are found to be penetrated by fungous hyphae. Whether or not the fungus is directly responsible for the abnormal activity of the phellogen is a point which is being investigated at the present time. The true cambium appears to be stimulated proportionally to a much smaller degree and produces relatively small amounts of abnormal woody tissue. Furthermore, entomologists agree that insects are not responsible for the damage. It is quite evident, then, that we have to deal here with a serious disease. Sorauer[2] observed resinosis which, in his opinion, arose "autogenously without wound stimulus" in the case of seedling pines "from heavily manured nurseries," as well as "in older plants of *Pseudotsuga Douglasii, Abies Fraseri* and *Abies concolor*" growing "on moist marshy soil which had been heavily manured at intervals of two or three years." The soil at the Goddard Memorial Park is decidedly dry and sandy and, so far as known, has never been heavily manured. The weight of evidence in this case, then, is in favor of a reaction to a wound stimulus as the more probable explanation.

In conclusion it may be stated that the condition of the Douglas firs at Potowomut bears a striking resemblance to that noticeable on many of the Douglas firs at the Matthews Arboretum and the Palmer estate located at Hamilton and Ipswich, Massachusetts, respectively. The trees at the Massachusetts estates have been carefully studied in connection with the larch canker caused by the fungus, *Dasyscypha Willkommii* (Hartig) Schröter. New stations have been discovered in several other Massachusetts towns and the disease apparently is more wide spread than was formerly thought probable. It appears to be a serious menace to the growing of Douglas fir in this part of the country at least. How seriously it may threaten the Douglas fir forests of the west remains for further investigation to determine.

NATHANIEL O. HOWARD

OFFICE OF FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
IN COOPERATION WITH THE
DEPARTMENT OF BOTANY,
BROWN UNIVERSITY

[2] Paul Sorauer, "Manual of Plant Diseases," third edition, volume I, translated by Frances Dorrance, page 715–716. 1914.